Biomass for Electricity Generation

Zia Haq
Energy Information Administration

Renewable Energy Modeling Workshop
April 20, 2004

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Presentation Outline

- Introduction
  - Assumptions and methodology for the biomass forecast in NEMS
  - Why are biomass supplies of concern?
  - Biomass forecast under reference-case assumptions and other scenarios
- Modeling inputs and methodology for forecast
  - Capital cost
  - Availability of feedstocks
- Forecasts - Reference case, high renewables case, carbon constraint case, and their implications
- Conclusions

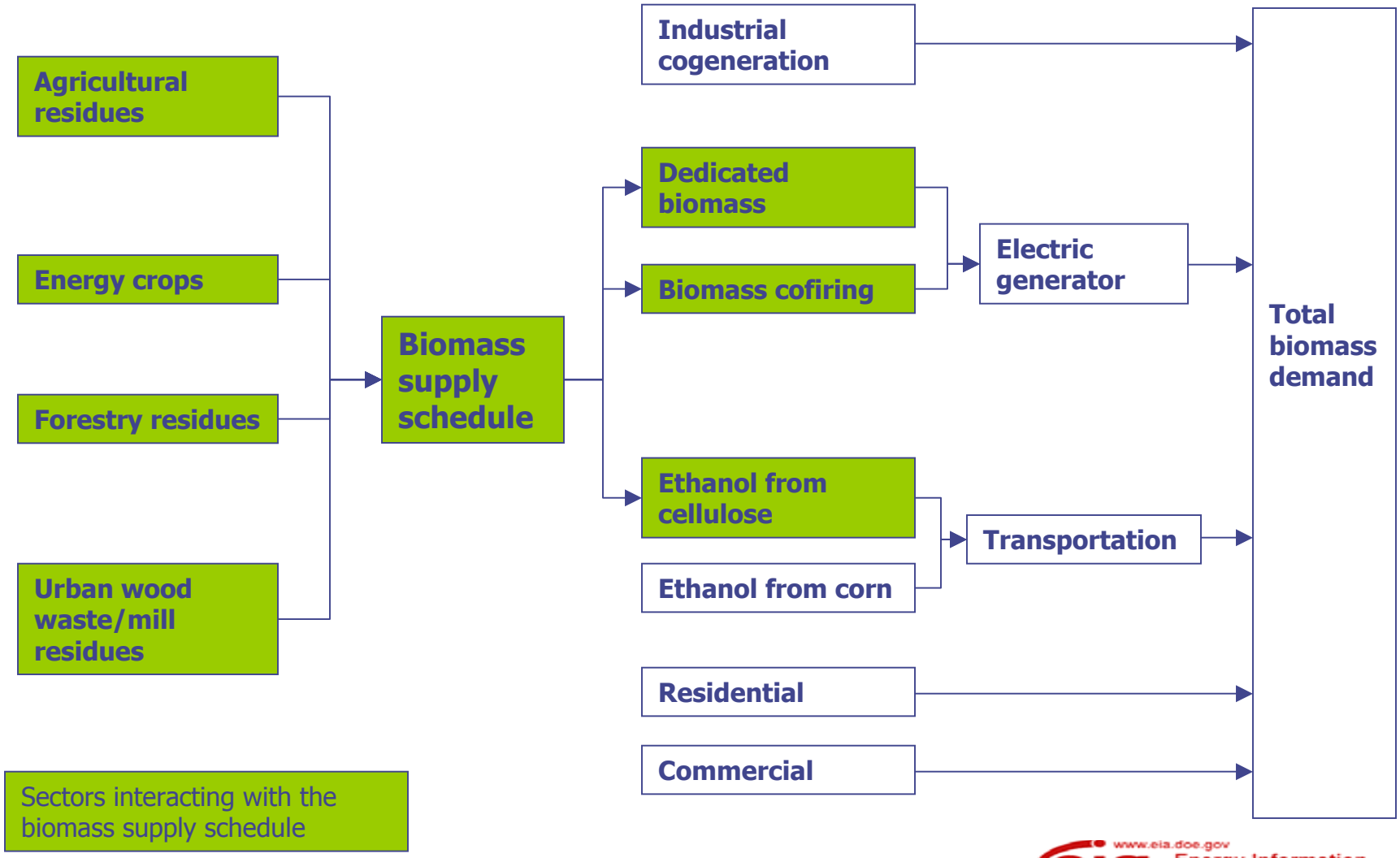
Biomass Activities at EIA

- Annual Energy Outlook
- Analysis of proposed Federal legislation
  - Senators McCain and Lieberman, S.139, "Climate Stewardship Act of 2003", greenhouse gas limits
  - 10% Renewable portfolio standard
  - Conference Energy Bill (Energy Policy Act of 2003)
    - Extends production tax credit for renewables
    - Biomass cofiring becomes eligible for production tax credit
    - Significantly increases biomass cofiring but impact is temporary
  - Inhofe, Carper, Jeffords bills (S.1844, S.843, S.366) – SO_2, NO_x, greenhouse gas and mercury reductions
- Potential updates to biomass supplies – agricultural residues, Healthy Forest Initiative

Why Are Biomass Supplies of Concern?

- AEO2004 reference case: business-as-usual scenario, current laws and regulations, fossil energy dominance
- AEO2004 High renewables case: optimistic renewable technology assumptions, higher growth of renewables
- S.139 "Climate Stewardship Act ot 2003" – Sen. McCain and Lieberman: high demand for biomass due to high carbon allowance prices
- Can biomass substitute for fossil fuels on a large scale in carbon-constrained or RPS cases?

Biomass Utilization in NEMS



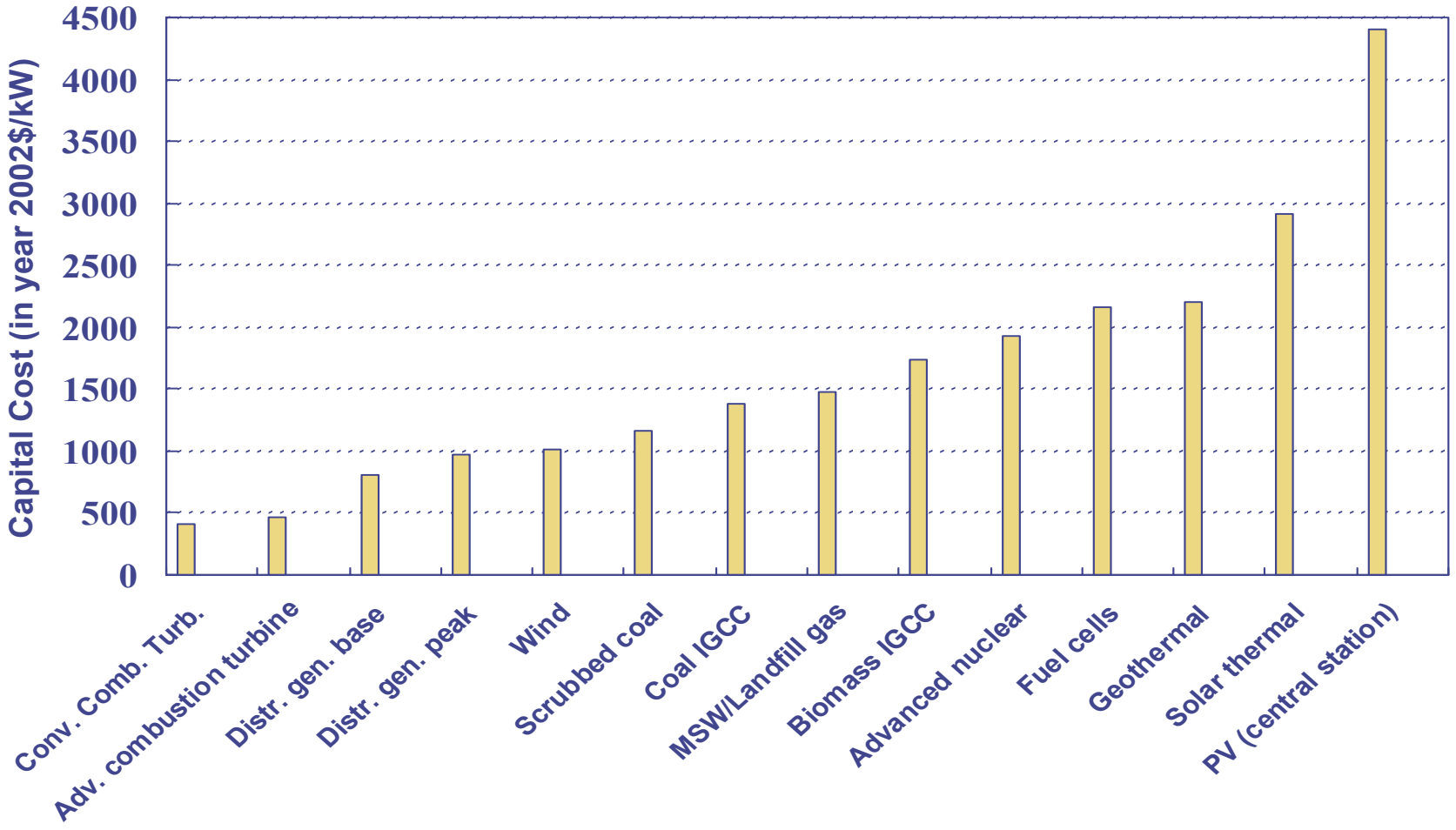
Biomass* Capital Cost Assumptions in NEMS

Attribute	Value
On-line year	2007
Unit size	80 MW
Construction lead time	4 years
Overnight cost (in year 2002$)	$1,588/kW
Contingency factor	1.07
Technological optimism	1.02
Total cost in 2003	$1,731/kW
Total cost in 2025	$1,460/kW**

* For a biomass integrated gasification and combined cycle power plant

** Capital cost under AEO2004 reference case in 2025

Total Capital Cost of Various Electricity Generating Technologies



Costs include contingency and technological optimism, but does not include regional multipliers

Source: EIA, "Assumptions to the Annual Energy Outlook 2004 (AEO2004)", February 2004, Table 38, p. 71

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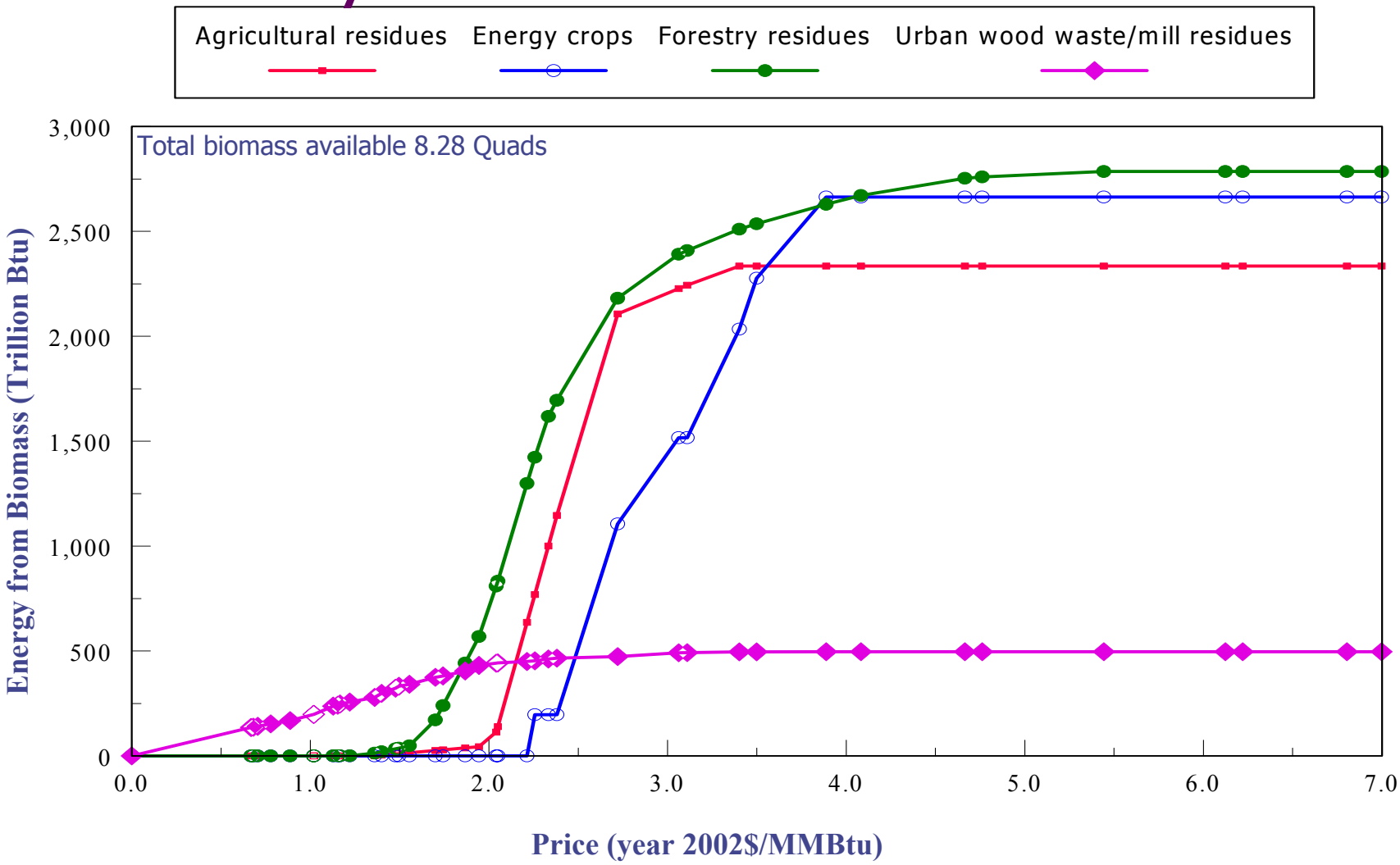
Biomass Supply Schedule Components

- Forest products: salvageable dead wood, logging residues, and excess polewood
- Urban wood waste and mill residues: mill residues, urban wood waste, and construction and demolition debris
- Agricultural residue: wheat straw and corn stover
- Energy crops: switchgrass, hybrid poplar and hybrid willow (assumed to be available on a commercial basis beginning in 2010)

Availability of Biomass in U.S.



Source: Oak Ridge National Laboratory and Antares Corp.

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Maximum Available Biomass Quantities

Biomass type	Quantity per year (million tons, dry)
Agricultural residue	136
Energy crops	155
Forestry residues	162
Urban wood waste/mill residue	29
Total	**482**

- Energy crop quantity changes from year to year due to harvesting schedule
- Agricultural residue, forestry residue, and urban wood waste/mill residue quantities have no time dependant variation

Assuming biomass energy content 8,600 Btu/lb (dry)

Source: Oak Ridge National Laboratory and Antares Corp.

Biomass Transportation Cost Assumptions in NEMS

- Transportation cost included in all feedstock types and therefore supply curve represents delivered price (farm + transportation cost)
- Urban wood waste and mill residues transportation cost: $0.24/ton-mile, maximum supply distance 100 mile radius
- Forest residues, agricultural residues, energy crops transportation cost: $10/ton and a maximum supply distance of 50 mile radius
- No biomass is transported across NEMS regions or greater than 50 to 100 miles

U.S. Energy Consumption in 2003

Energy source	Consumption (Quads)
Conventional hydroelectricity	2.79
Biomass (wood, black liquor, other wood waste)	2.09
Waste (MSW, LFG, other biomass)	0.56
Ethanol	0.24
Geothermal	0.30
Photovoltaics and solar thermal	0.06
Wind	0.11
Renewables	**6.15**
Coal	22.70
Natural gas	22.45
Petroleum	39.07
Nuclear	8.00
Pumped storage	-0.09
Total	**98.11**

- Biomass accounted for 2.65 Quads or 2.7% of total US energy consumption in 2003, second highest among renewable energy resources
- Renewables (including conventional hydroelectricity) accounted for 6.3% of total US energy consumption in 2003

Source: EIA, Monthly Energy Review, March 2004

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"Climate Stewardship Act of 2003"

- Senators John McCain and Joseph Lieberman introduced S.139 in January 2003
- Limits emissions of CO_2, CH_4, NO_x, HGWP gases through system of tradable emission allowances
- Sources industrial, electric power sectors, transportation uses, producers and importers of HGWP gases
- Phase I cap in effect from 2010 to 2015, based on emissions in 2000
- Phase II cap in effect after 2015, based on 1990 emissions
- EIA was asked to analyze impacts
- Report published June, 2003 on EIA web site http://www.eia.doe.gov/oiaf/analysis.htm

Capacity Forecasts Under Different Scenarios (GW)

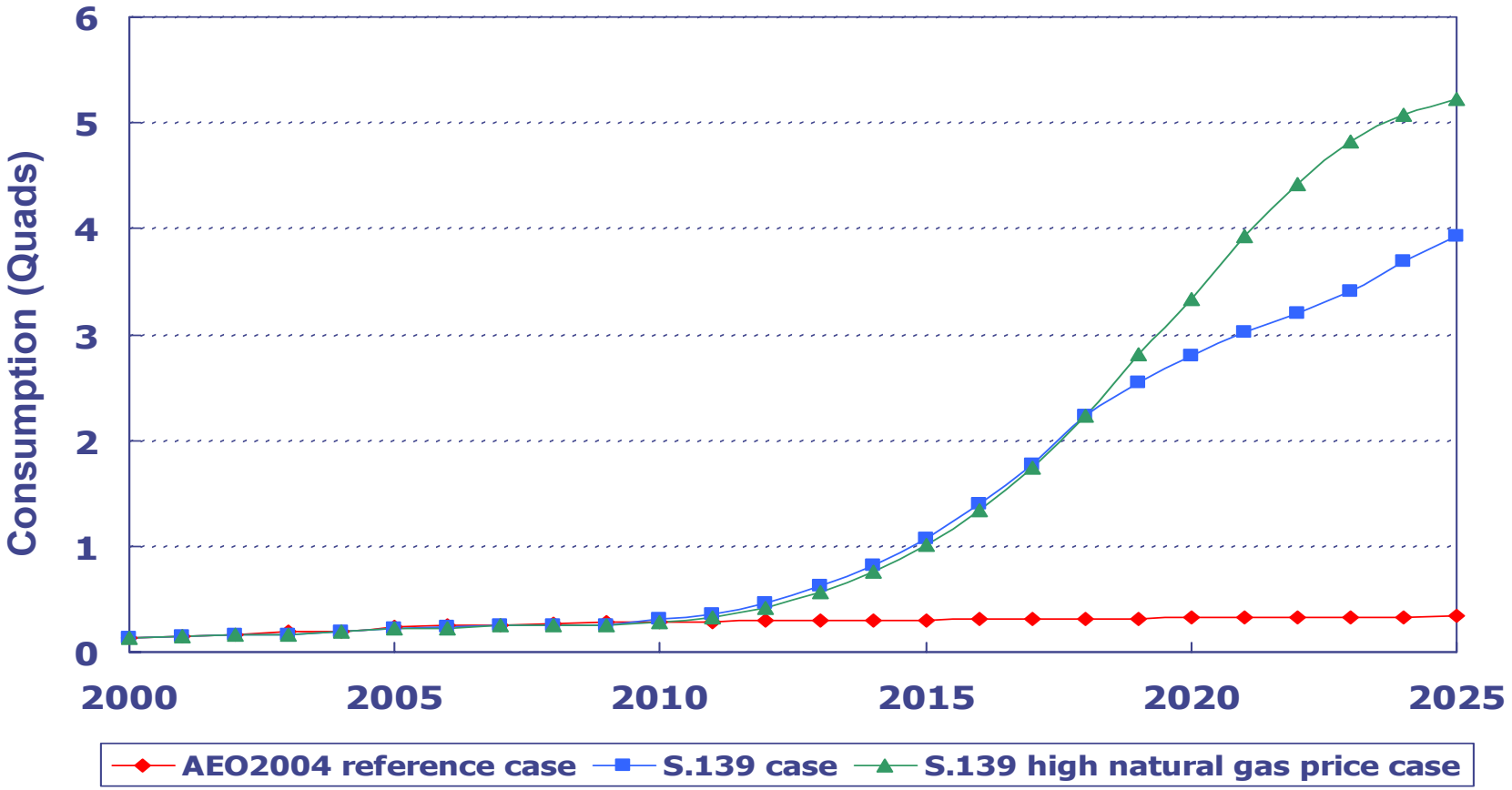
Sector	2002	AEO2004 Reference Case, 2025	S.139 Case, 2025	S.139 High Natural Gas Price Case, 2025
Electric generators*	1.83	3.74	67.4	87.4
Industrial cogenerators	3.91	8.03	8.6	8.6
Biomass capacity	**5.74**	**11.77**	**76.0**	**96.0**
Total installed capacity**	**921**	**1,217**	**1,216**	**1,264**

* Dedicated biomass only. Does not include biomass cofiring. Does not include municipal solid waste/land fill gas facilities.

** Includes electric generators and cogenerators

AEO2004 reference case: aeo2004.d101703e, S.139 case: mlbill.d050503a, S.139 high natural gas price case: mlbill_hgp.d052303a

Biomass Consumption Under Different Scenarios



Includes dedicated biomass, biomass cofiring, and ethanol from cellulose

Source: NEMS runs Reference case: aeo2004.d101703e, S.139 case: mlbill.d050503a, S.139 high gas price case: mlbill_hgp.d052303a

Characteristics of Biomass Cases

Case	Natural gas price*, 2025 (2002$/MMBtu)	CO_2 allowance price**, 2025 (2002$/mtce)
AEO2004 reference	6.03	0
S.139	8.34	224
S.139 high gas price	9.50	217

* Average price for all users

** 2002$/million tons of carbon equivalent, to meet S.139 goals of stabilization at 2000 levels by 2010 – 2015 and reduction to 1990 levels after 2015

What Drives Biomass?

- Climate policies – "Climate Stewardship Act of 2003", Sen. McCain and Lieberman, S.139 stabilization of GHG's at 2000 levels by 2010 to 2015, GHG reduction to 1990 levels after 2015
- Renewable portfolio standards – 10% RPS versus 20% RPS
- Production tax credits – long term permanent extensions versus short term year-to-year extensions
- High and sustained natural gas prices
- Technological innovations that lead to reduced cost – ethanol from cellulose, biomass gasification
- Policies with respect to other generation technologies – nuclear, coal, natural gas

DOE's Biomass Feedstock Roadmap

- Biomass will provide by 2030:
  - 5% of the nation's power
  - 20% of transportation fuels
  - 25% of chemicals
- This will require 1 billion dry tons per year of biomass to be available
- Must be done in a sustainable and economically feasible manner

Comparison to DOE's Biomass Feedstock Roadmap

Biomass type	Available quantity in NEMS (million dry tons/year)	Feedstock roadmap requirement (million dry tons/year)
Agricultural residues	136	150
Energy crops	155	159
Forestry residues	162	304
Urban wood waste/mill residues	29	387
Total	**482**	**1,000**

Supply Curve Uncertainties

- Competing uses of biomass – mulch market
- Agricultural waste: Impact of biomass removal on soil quality
- Forestry residues: Impact of changes in fire prevention policies
- Urban wood waste/mill residues: Impact of increasing quantities of recycling
- Energy crops: Competing uses of land (commodity crops versus energy crops)

Conclusions

- Maximum of 482 million dry tons of biomass available
- AEO2004 reference case capacity grows from 5.7 GW in 2002 to 11.8 GW by 2025
- S.139 case capacity grows to 76 GW by 2025
- S.139 high natural gas price case capacity grows to 96 GW by 2025
- Paper available at: http://www.eia.doe.gov/oiaf/analysispaper/index.htm
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